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Environmental regulation in transition: Policy officials' views of regulatory instruments and their mapping to environmental risks

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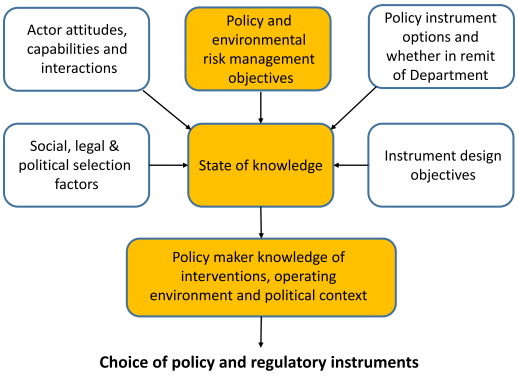
HIGHLIGHTS

- 14 interviews with policy officials re-analysed instrument selection and environmental risk.
- Positive, negative and neutral framings illustrated how instruments were perceived.
- Low overlap between instrument category and risk significance suggests other influences in play.
- Improved knowledge exchange is recommended for risk analysis and policy communities.

GRAPHICAL ABSTRACT



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ABSTRACT

This study re-analysed 14 semi-structured interviews with policy officials from the UK Department for Environment, Food and Rural Affairs (Defra) to explore the use of a variety of regulatory instruments and different levels of risk across 14 policy domains and 18 separately named risks. Interviews took place within a policy environment of a better regulation agenda and of broader regulatory reform. Of 619 (n) coded references to 5 categories of regulatory instrument, 'command and control' regulation (n = 257) and support mechanisms (n = 118) dominated the discussions, with a preference for 'command and control' cited in 8 of the policy domains. A framing analysis revealed officials' views on instrument effectiveness, including for sub-categories of the 5 key instruments. Views were mixed, though notably positive for economic instruments including taxation, fiscal instruments and information provision. An overlap analysis explored officials' mapping of public environmental risks to instrument types suited to their management. While officials frequently cite risk concepts generally within discussions, the extent of overlap for risks of specific significance was low across all risks. Only 'command and control' was mapped to risks of moderate significance in likelihood and impact severity. These results show that policy makers still prefer 'command and control' approaches when a certainty of outcome is sought and that alternative means are sought for lower risk situations. The detailed reasons for selection, including the mapping of certain instruments to specific risk characteristics, is still developing.

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1. Introduction

1.1. Policy context

Around the world, policy makers choose a range of policy and regulatory instruments to achieve their governments' environmental and economic objectives (Hood et al., 2001; Esty and Porter, 2005). 'Regulation', in its broadest sense, includes all forms of social control, including those that harness forces beyond government, such as the influence of businesses and other actors in society (Gunningham and Sinclair, 1998, 1999; Gunningham, 2009, 2011). 'Instruments' refer to one component of regulation, such as licensing, taxes or public information campaigns. Instruments include conventional direct regulation based on licensing and inspection; economic instruments such as taxes and subsidies; approaches to changing behaviour through better information provision; and approaches negotiated between government and industry, relying on industry self-regulation and seeking to increase knowledge and capacity.

Direct ('command and control') regulation has delivered significant environmental improvements in industrialised nations. It has been applied widely for circumstances where a certainty of regulatory outcome is desired; as a back stop to prevent 'free-loaders'; where there is a need for actors to adopt measures quickly; and to secure public confidence when combined with a system to ensure implementation. However, concern it may inhibit innovation and international competitiveness (Cabinet Office, 1999; Heyes, 2009; Rennings and Rammer, 2011; Iraldo et al., 2011) has led governments to seek alternatives (Obama, 2011; Australian Government Department of Finance and Deregulation, 2013; Department for Business Innovation and Skills, 2013a, b, c) and to target regulation using risk-based approaches (e.g. Pollard et al., 2004, 2008; Hampton, 2005; Gouldson et al., 2009). In practice, instruments rarely operate in isolation; instead forming a complementary mix influencing behaviours through different levers and across multiple actors. Furthermore, the genesis of regulations may dictate the approach to be taken (e.g.) European-derived legislation may require a 'command and control' approach to be taken; whereas certain economic instruments, such as taxes, can only be introduced by the treasury of the state; and other approaches may require cross-departmental agreement. With various changes occurring to the mix of instruments used, commentators observe a shift from *government* to *governance*, as alternative or mixed strategies are deployed for the protection of environmental goods and services (Jordan et al., 2005; Gouldson, 2008) and for the shared management of public risk and the associated costs (e.g. MacDonald et al., 2011).

The European Commission (2010) has a long-established programme for regulatory reform across its Member States and has sought to progress the 'better regulation' agenda towards so-called 'smart regulation' (European Commission, 2010). The Organisation for Economic Co-operation and Development (OECD) has promoted similar reforms (OECD, 1995, 2005, 2006, 2007, 2008, 2012). Emerging economies experiencing rapid industrialisation and growth are designing effective regulatory frameworks to deliver sustainable development (see Mejia, 2009). For example, China endorsed its Plan for Energy Conservation and Emission Reduction for the 12th Five-Year Plan (Ministry of Environmental Protection People's Republic of China, 2012), which included strengthened pollution controls and reduction targets for specific sectors, as well as the promotion of environmental management labels for vehicles.

The UK Department for Environment, Food and Rural Affairs (Defra) develops environmental policy and, with its agencies, regulation across multiple and complex policy domains. Regulation is implemented by Defra's network of agencies including the Environment Agency (EA) and also its regulators in local government. Programmes of regulatory reform have been pursued by successive UK governments (Cabinet Office, 1999; HM Government, 2011, 2012). For example, the 'Red Tape Challenge' (Defra, 2012; Cabinet Office, 2013) sought to reduce regulatory burdens through a process in which policy makers, politicians and the public scrutinized existing legislation to identify '*what should be scrapped, what should be saved and what should be simplified*'. Simultaneously, the UK government sought to reduce government spending while devolving more decision-making to a local level, including through voluntary civic action (Department for Communities and Local Government, 2011).

Policy makers and regulators face the challenge of selecting suitable instruments and implementation approaches: to meet multiple objectives of reducing risk; encouraging clean growth; reducing the bureaucracy associated with regulation; and for protecting and improving environmental quality. They can be hampered in their pursuit of 'evidence based policy' (Solesbury, 2001) by a lack of evidence on *which* policy and regulatory instruments work, *why*, *when* and with *whom* (Taylor et al., 2012), hence our motive to explore factors influencing the effectiveness of instruments in practice, to assist policy makers in delivering better regulation.

1.2. Better regulation, by design

Regulation is in transition (Cabinet Office, 2017). For environmental protection, recognition of the need to manage organisational governance and behaviours, in addition to limiting point source and diffuse releases to the environment, has prompted a wide discussion of instrument effectiveness. Policy makers and regulators have a diverse palette of instruments (Fig. 1) to select from, for effecting change by reference to risk (see caption) and other factors (Taylor et al., 2012, 2013, 2015).

Notwithstanding the various policy units established to rethink 'better', 'smarter' and 'lighter-touch' regulation (Environment Agency, 2011; Defra, 2013; Department for Business Innovation and Skills, 2013a, b, c), there appears a mismatch between the polemic on what is desired through these initiatives and the capacity of stakeholders to deliver fleet-of-foot solutions (Jordan et al., 2003; Rothstein et al., 2006). We have previously commented on instrument selection criteria (Taylor et al., 2012); factors influencing instrument choice (Taylor et al., 2013); and business preferences for regulatory reform (Taylor et al., 2015). Important aspects for the selection of any instrument (Fig. 1) include: (i) the market failure at play that warrants intervention; (ii) the nature of the environmental hazard whether to, or from the environment, and the consequences that might ensue if that hazard is realised, taking into account the state of the environment at risk; (iii) the likelihood of the consequences being realised, given the market or regulatory controls already in place – the so-called 'residual risk'; (iv) the nature, or character of the associated harms that might ensue from residual risks, how they are expressed, through which environmental compartments (air, water, soil, biota) and with what end result(s); (v) the opportunities to intervene at source, or along the point of hazard realisation (pathway) or at the receptor; (vi) the relative influences of individual human error, organisational behaviour, technological failure, or system failure on the probability of the hazard being realised (Defra, 2011a); and, critically (vii) the desired environmental outcome. These aspects of risk thinking, as they relate to the regulatory craft (Gouldson et al., 2009; Sparrow, 2000, 2008) have become woven into policy design in many nations, not least within regulatory impact appraisal (Kirkpatrick and Parker, 2007; HM Treasury, 2003), with its attempts to quantify cost-benefit quotients for interventions by reference to their intended environmental benefits.

In our research, Taylor (2013) has commented on the adoption of risk concepts by policy officials designing interventions, notably in the context of contaminated land, soil erosion, animal and plant disease control, climate change adaptation planning, chemicals regulation, flood risk management, reservoir safety and infrastructure investment. Risk characteristics that reportedly influenced the choice of instruments included (Taylor, 2013):

(i) the spatial characteristics of risk (13 respondents): risks that vary spatially required local assessments of risk (e.g. flooding, land contamination, diffuse pollution, biodiversity, river pollution) and possibly national coordination or international agreements

Type of instrument used or supported	Ways government can influence business behaviour	Types of risk to target	Effectiveness	Costs and efficiency	Industry suitability
1: DIRECT "COMMAND AND CONTROL" REGULATION	Require businesses to comply with rules, enforced with sanctions.	Target at highest impact risks. H	Relatively high, if enforced.	Relatively costly to government and business. Typically less flexible for businesses.	Widely used. Enforcement more difficult for multiple small businesses.
2: ECONOMIC INSTRUMENTS	Change economic incentives for businesses.	Can be targeted at major risks. M	Relatively high; outcome less certain than direct regulation.	Can be costly to businesses and government. Allow greater flexibility to businesses.	Widely used. Typically target specific products or emissions (e.g. waste to landfill, water use).
3: CO-REGULATION	Negotiate with a group of businesses to agree targets to be achieved.	Typically targeted at lower risks. M/L	More likely to be effective if participation provides business advantage (e.g. reduced costs, more sales).	Typically lower cost to government than direct regulation but can still be costly for businesses. Afford greater flexibility.	Easier where industry has capacity to coordinate own activities. Large businesses typically easier to engage than small businesses.
4: INFORMATION BASED INSTRUMENTS	Provide better information to customers and other stakeholders.	Typically targeted at lower risks. M/L	Less certain; dependent on environmental concern of customers/consumers.	Lower cost to government.	Customers / consumers need to prefer products with better environmental performance.
5: CIVIC AND SELF-REGULATION	Promote or reinforce other social influences on good environmental performance.	Typically supported by government for lower risks. Can be useful for exploring new or poorly understood problems. M/L	More likely to be effective where better environmental performance provides business advantage (e.g. reduced costs, more sales).	Typically zero/ low cost to government but can still be costly for businesses. Afford greater flexibility.	Dependent on presence/ strength of influence of external stakeholders.
6: SUPPORT AND CAPACITY BUILDING	Improve knowledge and skills of businesses to promote better practices or better technology.	Typically target R&D resources at highest priority risks. H	Difficult to predict and measure, with some failures likely.	Costs can be significant e.g. for demonstration projects.	Used for many industries.

Fig. 1. Summary of options for instrument selection. In this study, we collapse instrument types 3 (co-regulation) and 5 (civic and self-regulation) into a single category. Taylor (2013) previously hypothesised a mapping of risk characterisations (High, Moderate, Low) to these instrument categories (column 3, Fig. 1).

where impacts crossed administrative boundaries;

(ii) the risk character (13 respondents): risks with severe impacts were argued to require more certain measures to control them, normally through direct regulation (e.g. reservoir safety, chemicals, pesticides, air pollution, drinking water quality, release of invasive species);

(iii) the receptor(s) affected (6 respondents): where the impact of a risk is constrained to the person or business causing the risk, it was argued that government need not intervene. However, where risks caused by one party imposed impacts on others (e.g. the introduction of animal or plant disease) or where risks to society remain unmanaged (e.g. risks arising from climate change not managed by private sector organisations) it was argued that government intervention may be justified on market failure grounds;

(iv) the complexity of actors and mitigation actions required (3 respondents): for issues such as soil management, climate change adaptation planning and diffuse pollution, more complex approaches using a range of interventions targeted at different actors were reported to often be necessary;

(v) existing understandings of risk (6 respondents): risks that are not well understood (e.g. engineered nanomaterials) require different regulatory approaches compared to well understood risks. Interviewees discussed precautionary approaches or securing a better evidence base before direct regulation was adopted;

(vi) persistence and irreversibility (3 respondents): some impacts persist in the environment, or are irreversible (e.g. some chemicals, invasive species) in which case stronger controls to reduce residual risk were reported to be appropriate;

(vii) the speed of action required (3 respondents): where rapid government action was required, say to control the spread of animal disease after an outbreak, direct regulation was argued to be necessary, alongside contingency planning and skills development to improve emergency response. Flood risk management also requires measures (e.g. emergency planning, flood alerts) to enable a rapid response.

These high level observations suggested a nuanced understanding of risk concepts among policy officials. An extensive literature exists on the relationship between the characteristics of risks and the forms of regulation appropriate to managing them (e.g. Klinke and Renn, 2002; Pollard et al., 2004) and our preliminary results suggested concepts from economics (e.g. Perman et al., 2003) and risk analysis (e.g. Kaplan, 1997; Short, 1984) were used by policy makers at Defra to conceptualize explanations for instrument selection, but to varying degrees by different interviewees. This could indicate that economic and risk theory are of varying relevance in different policy domains; or that expertise and experience in risk and economics is not spread evenly among policy makers; or even that in some domains, there was a deliberate avoidance of technical terminology to aid the clarity of communication. In our preliminary analysis, we concluded (Taylor, 2013; Taylor et al., 2013) that policy officials generally considered direct regulation necessary in circumstances where high impact public risks occurred. Scope for alternative approaches to direct regulation, where residual risks may still be high, depended on the strength of supply chain relationships; the capacity and motivation of the business sector to self-regulate; the strength of political commitment to regulation and non-direct regulatory approaches; and the exposure of businesses in the sector to public and non-governmental organisation (NGO) scrutiny (Taylor, 2013). In addition, certain measures such as taxes and other fiscal instruments may be the remit of the Treasury, rather than the environment department, or may demand cross-departmental inputs, in which case the views of one department's officials may not offer a complete picture.

1.3. Objectives and research questions

Our long-standing interest has been the framing of, and connection between, the themes of market failure, intended outcomes, risk characterisation and instrument selection; and the deep understanding, or otherwise, of these by the actors involved (Dahlstrom et al., 2003; Gouldson et al., 2009; Pollard et al., 2008; Prpich et al., 2011; Taylor, 2013). Without a deep understanding of the interplay between these

themes, better regulation, in our opinion, is unlikely to find traction. The overarching purpose of this research therefore was to explore the views of policy officials engaged in the better regulation debate, and their views on instrument selection related to risk. We sought to examine the axis between regulatory design, for a range of policy domains as to their risks, and the perceived effectiveness that interventions have on the management and reduction of risks within that domain. Our examinations have wider appeal given the prioritisation of policy effort (and public funds) directed towards strategic risks faced by the UK, and elsewhere. We therefore ask: (a) *how do policy officials perceive the effectiveness of existing or proposed interventions in reducing risk?* (b) *what place does risk reduction, as a desired policy outcome, play in instrument selection?* (c) *to what extent and how do policy officials connect with these aspects during instrument selection?*

2. Materials and methods

2.1. Sample and procedure

We analysed 14 in-depth, semi-structured interviews from an original interview set conducted in 2013 with 33 policy officials across 25 policy domains. Each of the 14 interviews, selected as those with richer extended text, focused on a specific area of Defra's policy work, for example waste management, or marine licensing. A full list of policy domains is in Table 1. The original interviewer (CMT) spoke with between one and three policy staff at a time and interviews lasted between 27 and 67 mins. Prior to the original interview, interviewees had been provided with the aims of the research. At the outset, a summary was provided by the interviewer (CMT) reiterating the desired focus. Interviewees were encouraged to speak freely, though CMT provided minor guidance and prompting (Appendix) to ensure the discussion remained 'on topic'.

2.2. Quantitative content analysis

For a re-analysis of these interviews, a quantitative content analysis (QCA) was used to answer the research questions and obtain replicable findings. QCA ensures the data is statistically comparable (Muehlenhaus, 2010), allowing for objective measurements of difference. To carry out QCA effectively and validly, research questions must be determined through the prior establishment of relevant themes and codes. Each of the 14 extended interviews was therefore coded separately by the researcher (EAG) using NVivo™ software (Bazeley, 2007). The unit of coding was the paragraph and, where relevant, multiple codes were applied to the same paragraph. That is, if more than one relevant theme was mentioned within a paragraph, the paragraph was assigned to each relevant code. Regulatory instruments were categorised into five key categories (Taylor et al., 2012): 'command and control' regulation; co- and self-regulation; economic instruments; information based instruments; and support mechanisms (Fig. 1; Table 1). Few interviewees could meaningfully distinguish between co- and self-regulation and these categories were collapsed into a single one.

Our analytical approach drew from frame analysis, which is employed to analyse how the media presents information to the public by aggregating the number of 'pro' or 'con' statements relating to a given topic (Pan and Kosicki, 1993). For this study, references to regulatory instruments were coded as positive, negative or neutral, on the basis of how they were discussed by interviewees with regards to their perceived effectiveness. Environmental risks were predominantly coded using pre-determined risk categories reported by Soane et al. (2016). Previous work by the authors had informed the expression of these policy level risks. Risks included derogations to air quality and risks to the loss of biodiversity, for example (Fig. 2a). However, some additional and unique codes, derived from a lexicon of policy level risks generated during a Defra-funded programme of research on strategic risk management described by Prpich et al. (2011) were required for further risk categories that were identified during the previous study, such as land contamination and invasive species (Fig. 2b).

2.3. Overlap analysis for instruments and risk reduction

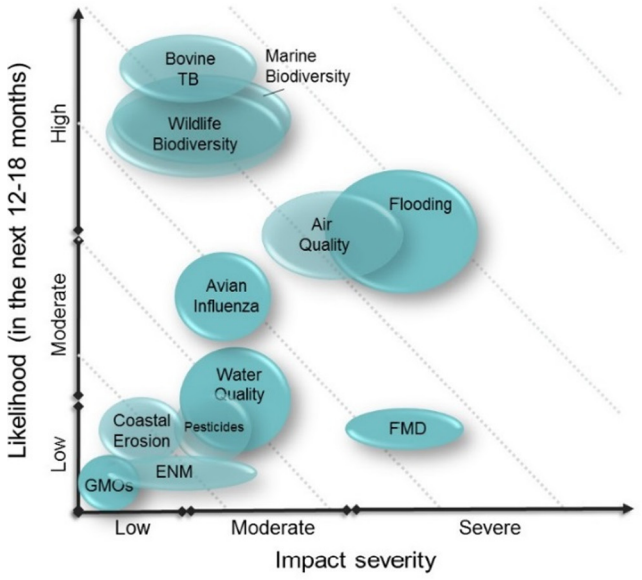
We were interested in whether policy officials could express a connection between the instruments discussed for various policy domains (Table 1) and accepted approaches to risk reduction for these domains. To test this, we used a strategic risk analysis, reported for Defra policy domains elsewhere (Prpich et al., 2011) (Fig. 2a–c), to which risk characterisations were added for the full set of risks discussed by the research team.

References to environmental risks were identified throughout the interviews. These consisted of 18 named risks by reference to 14 Defra policy domains presented in Table 1. References to each of the 18 named risks were compiled into new codes that corresponded to the proposed risk characterisation in Fig. 2a,b, by reference to likelihood

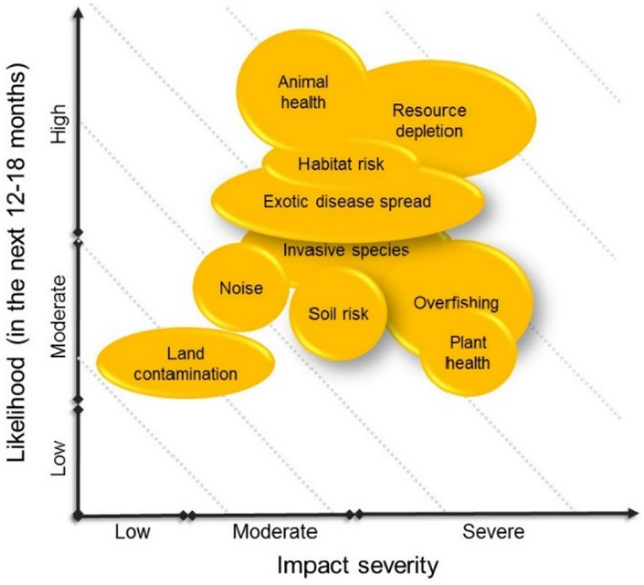
Table 1
Count and % distribution of references to instruments for 14 Defra policy domains.

Policy domain	Command and control		Co- and self-regulation		Economic instruments		Information-based instruments		Support mechanisms	
	N	%	N	%	N	%	N	%	N	%
Biodiversity	**18**[a]	8.33	9	8.82	–	–	–	–	6	5.66
Food	**32**	14.81	14	13.72	2	3.51	9	14.29	8	7.55
Marine strategy	**28**	12.96	16	15.69	1	1.75	4	6.35	4	3.77
Common fisheries policy	**29**	13.43	6	5.88	1	1.75	1	1.58	6	5.66
Peat and soils	**10**	4.63	**10**	9.80	1	1.75	4	6.35	7	6.60
Contaminated land	**15**	6.94	6	5.88	–	–	6	9.52	9	8.49
Food and Environmental Research Agency[b]	**21**	9.72	7	6.86	1	1.75	11	17.46	20	18.87
Waste management	4	1.85	4	3.92	**17**	29.82	5	7.94	7	6.60
Noise regulation	**10**	4.63	1	0.98	2	3.51	2	3.17	5	4.72
Chemicals regulation	**18**	8.33	5	4.90	2	3.51	5	7.94	6	5.66
Marine licensing	8	3.70	3	2.94	2	3.51	3	4.76	**12**	11.32
Local environmental protection[c]	11	5.09	6	5.88	**12**	21.05	2	3.17	4	3.77
Livestock and livestock products	6	2.78	3	2.94	4	7.02	2	3.17	**8**	7.55
Sustainable consumption and production	6	2.78	**12**	11.76	**12**	21.05	9	14.29	4	3.77
Total	**216**	100	**102**	100	**57**	100	**63**	100	**106**	100

[a] Bold text refers to prominent instruments noted in interview.
[b] The Food and Environmental Research Agency, an executive agency of Defra and international centre of excellence for plant and bee health, crop protection, sustainable agriculture, food and feed quality and chemical safety in the environment.
[c] Local environmental protection relates to Defra's interactions with local authorities who have regulatory duties and power most notably in relation to local air quality management.



(a) Policy-level risks from Soane et al. (2016)



(b) risks characterised in this analysis

(c) Risk management strategies and instruments by reference to risk character

Fig. 2. Risk characterisation. Strategic analysis of policy-level risks and taxonomy of instrument by reference to risk character (FMD, foot and mouth disease; ENM engineered nanomaterials; GMOs, genetically modified organisms; Bovine TB, bovine tuberculosis).

and impact categories. For example, references which were coded into 'plant health' and 'overfishing' (Fig. 2b) were combined to form the new code of 'moderate/severe' as both were presented as having a moderate likelihood and a severe impact. To determine which types of instrument were associated with each character of risk by policy officials in the interviews, an 'overlap analysis' was conducted with NVivo™. The analysis highlighted references where risk categories overlapped with references from the regulatory instrument category codes. For example, a reference coded to 'moderate/severe risk' and to 'command and control' was counted as an overlapping code. By way of background, Taylor (2013) previously hypothesised a mapping of risk type to 6 instrument categories (column 3; Fig. 1).

3. Results

3.1. Instrument preferences by policy domain

Table 1 presents the overall count and percent distribution of references by interviewees to the five key instrument categories for 14 Defra policy domains. It records the general preference in the transcripts (in bold) for 'command and control' (N = 257) and support mechanisms (N = 118) and, for each domain, the most cited instrument category. These can be reconciled by reference to existing approaches to the regulation of risks presented by these policy domains; e.g. 'command and control' regulation for contaminated land (N = 15), a policy domain

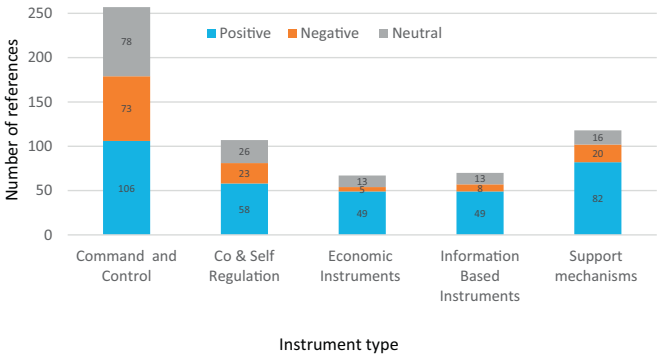


Fig. 3. Count for positive, negative and neutrally-framed references for each instrument category.

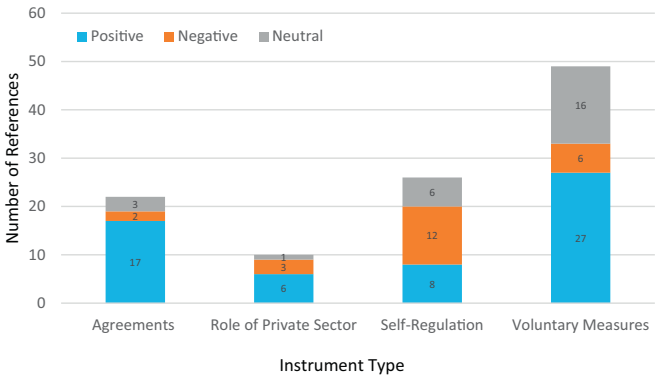


Fig. 5. Co-regulation and self-regulation sub-categories with positive, negative and neutrally framed references denoted.

that relies heavily on statutory and technical guidance to practitioners and local councils on the remediation of contaminated sites; or waste management which benefits from an effective economic instrument (N = 17), the landfill tax, to divert wastes from landfill disposal.

3.2. Frame analysis by instrument category

For the five key instrument categories, each code was categorised as positively, negatively or neutrally-framed. Framing was determined by EAG using references in the transcript. As a global data set across all policy domains, positively framed references accounted for just over half of all references (55%, N = 344), with negative references accounting for 21% (129), and neutral referencing comprising the remaining 24% (146). Fig. 3 is a stacked histogram of positive, negative and neutrally-framed references for five instrument categories. Economic instruments had the greatest percentage of positive references (73%) and the lowest percentage of negative references (8%) relative to the total number of references within the category. Command and control had the greatest percentage of negative references (37%) relative to the total category, though this category was referred to substantially more than each of the other four.

Next, the 'command and control' code was further categorised into five sub-categories (Fig. 4). References to EU directives and the European Commission (EU/EC; Fig. 4) were the most prevalent, with this category having the greatest number of references framed positively (N = 45), negatively (N = 36) and neutrally (N = 41). The local authority category possessed the greatest portion of positive references within the 'command and control' category, while the greatest percentage of negative references was in the legislation category. Overall, 'command and control' was predominantly positive with 44% of references coded to that frame.

Co- and self-regulation (combined) were categorised into four sub-categories (Fig. 5). Of the four, voluntary measures were discussed to a greater extent with 58 positively framed references. Agreements, the role of the private sector and voluntary measures each possessed a large proportion of positive references. Self-regulation was mostly discussed in a negative manner, with 46% of all references framed negatively in that category. Overall, 54% of references to co-regulatory and self-regulatory instruments were positive.

Economic instruments (Fig. 6) were reduced to four sub-categories, predominantly discussed in a positive manner; with general economic drivers comprising the majority of the references. Almost three quarters (73%) of references to economic instruments were positive, with just 8% negative. However, it should be noted that the total number of positive references overall was 49.

Information based instruments also formed four sub-categories (Fig. 7). Targeted information provision was rated most positively with 82% (N = 28) of references coded as positive. Civic regulation was shown to have the greatest percentage of negatively framed references with three negative references (38%). Over two thirds (70%) of references in the information based category were framed positively (N = 49).

Finally, support mechanisms were sub-categorised into three areas (Fig. 8). Network building and problem-solving exhibited the greatest number of positively framed references (N = 33). Raising awareness was shown to have the greatest percentage of positive references (79%) and lowest percentage of negative references (8%) relative to

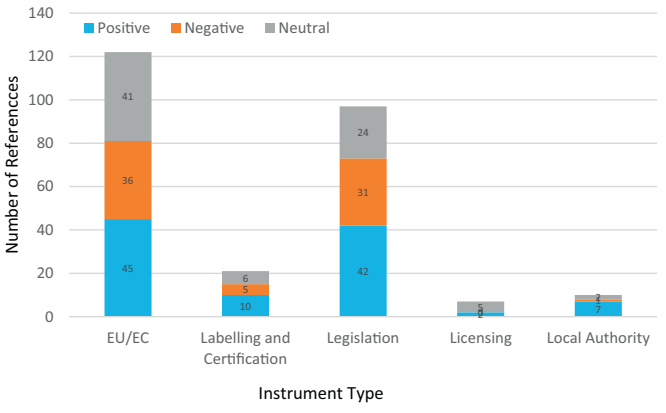


Fig. 4. Command and control sub-categories, with positive, negative and neutrally framed references for each sub category.

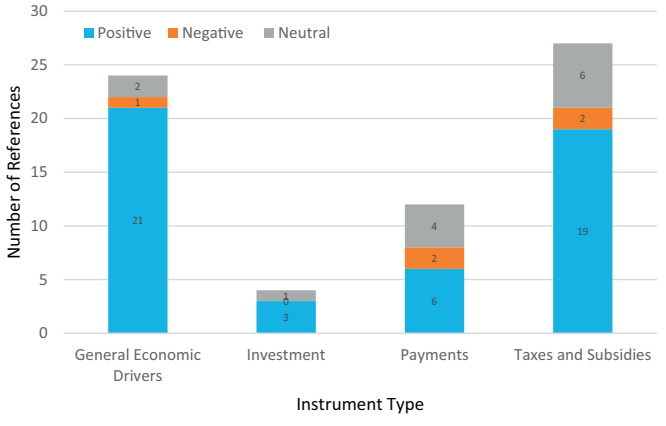


Fig. 6. The four sub-categories of economic instrument, with positive, negative and neutral references denoted.

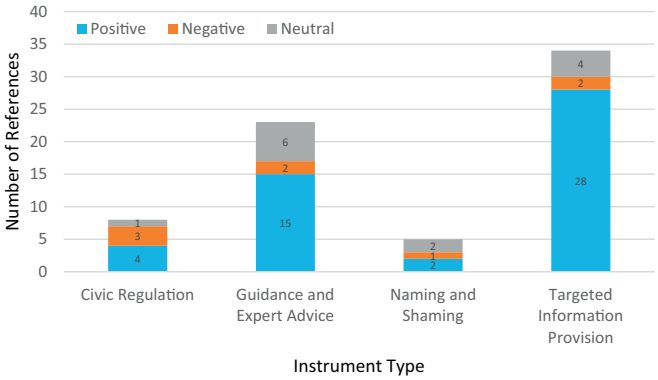


Fig. 7. Information based sub-categories, with positive, negative and neutral frames.

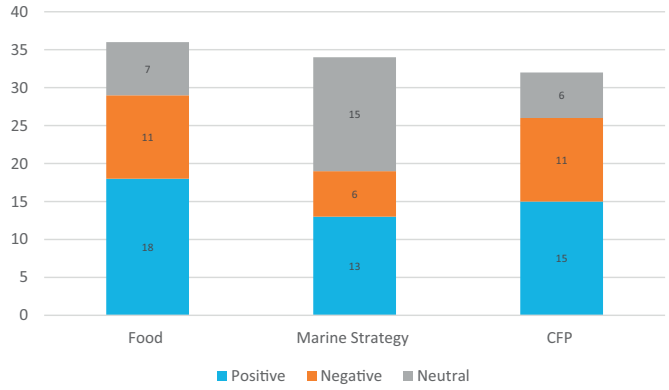


Fig. 9. Positive, negative and neutral breakdown of 'command and control' references for three areas with greatest mention of 'command and control' instruments (Food, Marine strategy and CFP, Common Fisheries Policy).

the total number of references within the category. Overall, references to support mechanisms were mostly positively framed (69%).

3.3. Instrument selection and risk reduction

Notwithstanding the value of policy officials' perspectives on these interventions in the midst of a better regulation debate, to what extent do policy officials correlate key instrument categories (Table 1; Fig. 3) with the risk reduction strategies these instruments are accepted to deliver? Ideally, one might hypothesise a strongly positive framing of 'command and control' by officials, as a category of intervention deemed effective at managing risks in need of firm and prompt enforcement. If this hypothesis was to hold, one might expect officials to map firm 'command and control' regulation to policy domains where residual risks were deemed to be high (Fig. 2b). If this capability was well-developed among policy staff, regulatory control, and thus instrument selection, might be anticipated to mirror the character of the harms presented by the risk (Sparrow, 2000, 2008). However, to temper this with reality, Fig. 9 presents the framing analysis for 'command and control' from our dataset for 3 policy domains (Food, Marine strategy, and regulation of the Common Fisheries Policy; CFP) with the greatest citation of this instrument category and the varying distribution of positive, neutral and negative references accordingly. Rather than reflecting a uniformly positive perspective, a variety of responses exists. Further, as discussed below, policy officials did not closely correlate the management of high likelihood/severe impact risks in general with command and control interventions, suggesting there additional influences beyond risk character are at play.

The overlap analysis described in Section 2.3 above is this study's attempt to examine a possible matching between instrument type and risk characterisations for the 18 risks named in the interview set and characterised accordingly (Table 2).

A set of normalised histograms (Fig. 10a–e) illustrates the extent of overlap for each of the characterisations of risk (e.g. high likelihood/severe impact) for each of the five governance and regulation categories.

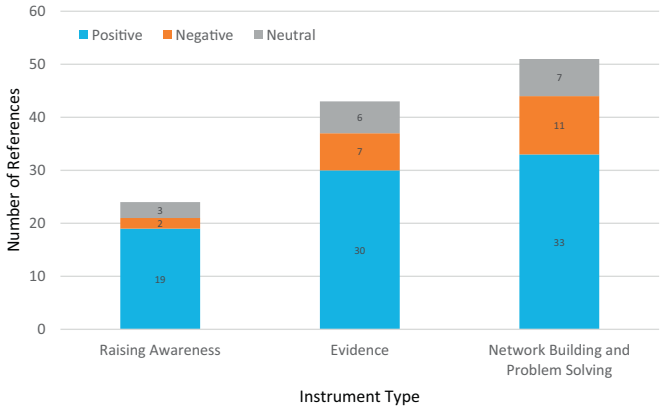


Fig. 8. Support mechanism sub-categories, with positive, negative and neutral frames.

4. Discussion

4.1. What do policy officials make of instruments in general?

Policy officials in Defra are clearly familiar (Table 1) with the operation of 'command and control' regulation (EU/EC regulation; Fig. 4) and the use of support mechanisms (evidence, network building and problem solving; Fig. 8) as two means of driving policy outcomes; though there are mixed views on whether 'command and control' approaches are necessary in all of the circumstances in which they are currently used (Fig. 4). For policy domains where multiple actors exist – the management of peat and soils quality and moves towards sustainable consumption and production – the data (Table 1) suggests awareness of co- and self-regulatory mechanisms to deliver change through voluntary measures (Fig. 5), though there are mixed views on effectiveness. This greater consideration of voluntary agreements is to be expected given the substantive momentum behind better regulation at the time of the interviews and an effective in-house unit coordinating Defra's efforts (Defra, 2011b, 2012, 2013). Table 1 also infers knowledge about risks where economic and fiscal instruments have been deployed, waste and local air quality management for example, with positive perspectives (Fig. 6) on taxes and subsidies and general economic drivers as effective instruments. We also note the high credit given to information-based instruments (Table 1, note food and FERA-centred activities) as alternative instruments within these domains. Overall, Table 1 and the attending Figs. 4–8 present a picture of a wider consideration of the potential policy instruments to use: there is sound understanding of instruments in use; a developing understanding of alternatives; and mixed views of their effectiveness.

4.2. To what extent is risk discussed in instrument selection?

A preliminary analysis in Taylor (2013) illustrated the extent of understanding among Defra policy officials about risk and economics concepts, summarised in Section 1.1. Building on this, Fig. 10a–f summarises the extent to which their discussions of instrument category for 18 named risks were accompanied by references to their specific risk character (Fig. 2a,b; and by the nominations 'high/severe'; 'high/moderate' etc.; Table 2; column 6). In short: (i) did policy officials map the instrument category to the magnitude of the risk, as hypothesised by Taylor (2013; Fig. 1); and (ii) did they give suitable

Table 2
Illustration of number of references and sources for each environmental risk type with their respective risk characterisations denoted by group, for ease of comparison.

			Risk characterisation[a]		Category (see Fig. 10a–f)
Named risk type	References (no.)	Sources	Likelihood	Impact severity	
Flooding[b]	1	1	H	S	High/severe[10a]
Resource depletion	3	2	H	S	
Impact to biodiversity	14	5	H	M	High/moderate[10b]
Marine biodiversity	5	3	H	M	
Habitat risk	6	2	H	M	
Animal health	5	1	H	M	
Plant health	9	1	M	S	Moderate/severe[10c]
Overfishing	3	1	M	S	
Air quality	6	3	M	M	Moderate/moderate[10d]
Water quality	10	7	M	M	
Pesticides	1	1	M	M	
Soil risk	6	1	M	M	
Invasive species	7	2	M	M	
Noise	8	1	M	M	
(Exotic animal) disease spread	5	1	M	M	
Coastal erosion	1	1	M	L	Moderate/low[10e]
Land contamination	9	2	M	L	
Nanomaterials	5	2	L	L	Low/low[10f]

[a] Risk characterisations by reference to Fig. 2a,b, as High, Severe; Moderate and Low.
[b] Named risks grouped by risk character 'couples' for ease of comparison with figs. below.

preference in their discussions to the instrument type most suited for managing the particular risk (Fig. 2c)?

Citation analysis (the length of the grey bars in Fig. 10c,d,e) was generally greater for 'high/moderate'; 'moderate/severe'; and 'moderate/moderate' risks than for the more extreme 'high/severe and 'low/low' risk characterisations. This may reflect the greater uncertainty that exists in the middle of the 'risk × impact' schematic (Fig. 2c) and thereby an enhanced reference to risk, or the number of named risks assigned to these particular categories (Table 2, column 6) compared to the others. Turning to the extent of overlap – the mapping of risk character to instrument type – Fig. 10a–f suggests a poor degree of sense making at the time of the interviews between risk character and instrument effectiveness. Mixed regulatory strategies are to be expected for risks of mixed character (Fig. 2c) because these are generally uncertain, complex in character and require formalised risk analysis to resolve their significance in likelihood and consequence terms. This appears to be borne out by Fig. 10c,d,e, though the absence of a close mapping for command and control' strategies for 'high/severe' risks is surprising given the preliminary finding noted in 1.2 above. We are cautious about conclusions when coding overlaps occur. The clearest single example is in Fig. 10d for 'command and control' and for those risks deemed 'moderate/moderate' (Table 2), and where support mechanisms also feature.

4.3. What does this tell us about instrument design and risk?

It would naïve to assume that the *character* (or significance) of a public risk in need of regulation, because of market failure, was the sole factor in selecting the instrument to manage it; or even that a single instrument alone could deliver the extent of risk reduction required (Sinclair, 1997; Jones, 2007; Angus and GHK-ICF, 2013). As Taylor explains (Taylor et al., 2012; Taylor, 2013; Fig. 1), there are multiple criteria in play during instrument selections. This said, policy makers and researchers have made progress (e.g. German Advisory Council on Global Change, 1998; Gandy, 1999; Klinke and Renn, 2002; Prpich et al., 2011; International Risk Governance Council, 2011; Kuklicke and Demeritt, 2016) in connecting risk character with the means by which risks can be managed – most obviously, 'low likelihood/severe impact' risks requiring contingency planning and information provision; and 'high likelihood/severe impact' risks requiring firm action now. However, our results suggest more knowledge exchange is required between the risk analysis and policy maker communities.

Within the support mechanisms category is the sub-category of 'evidence'. Evidence was referred to 43 times and was mentioned in twelve of the fourteen interviews. Thirty of these references were framed positively, and mostly related to the importance of using and gathering evidence to inform and support policy decisions. Overall, it was stated that there is a need for clear evidence to support their work, and where no evidence is available, this is problematic. Some of the discussion referred to the effectiveness of evidence based decisions and the importance using evidence to inform their processes, a discussion initiated by Garnett et al. (2016). Respected evidence is valuable and has the potential to have wider impacts and inform industry what works. More evidence is therefore needed to evaluate the risks in terms of severity and impact. The importance of evidence was noted across risk categories and in relation to all policy instruments. While evidence was categorised as an instrument for the purpose of this research, it is evident that it is also required to support many of the other instruments outlined above.

5. Conclusions

We return to our aims: (a) *how do policy officials perceive the effectiveness of existing or proposed interventions in reducing risk?* (b) *what place does risk reduction, as a desired policy outcome, play in instrument selection?* (c) *to what extent and how do policy officials connect with these aspects during instrument selection?*. This is the first evaluation of policy officials' perspectives of instrument selection by reference to risk (see graphical abstract). Though modest in its scope, it appears policy officials possess a sound grounding in generic risk and economic concepts, perhaps through their training in formal policy appraisal within government and in cost-benefit analysis. Similarly, their understanding of conventional regulatory instruments is well grounded and furnished with occasional examples of alternatives, such as economic instruments, information-driven instruments and voluntary agreements. However, beyond the generalities of the need for risk reduction through 'command and control', there is a need to understand other factors that affect instrument choice and improve the connection between the significance and character of risks with instrument choice – not only in the Government department sponsoring policy development, but also through engagement with other government departments.

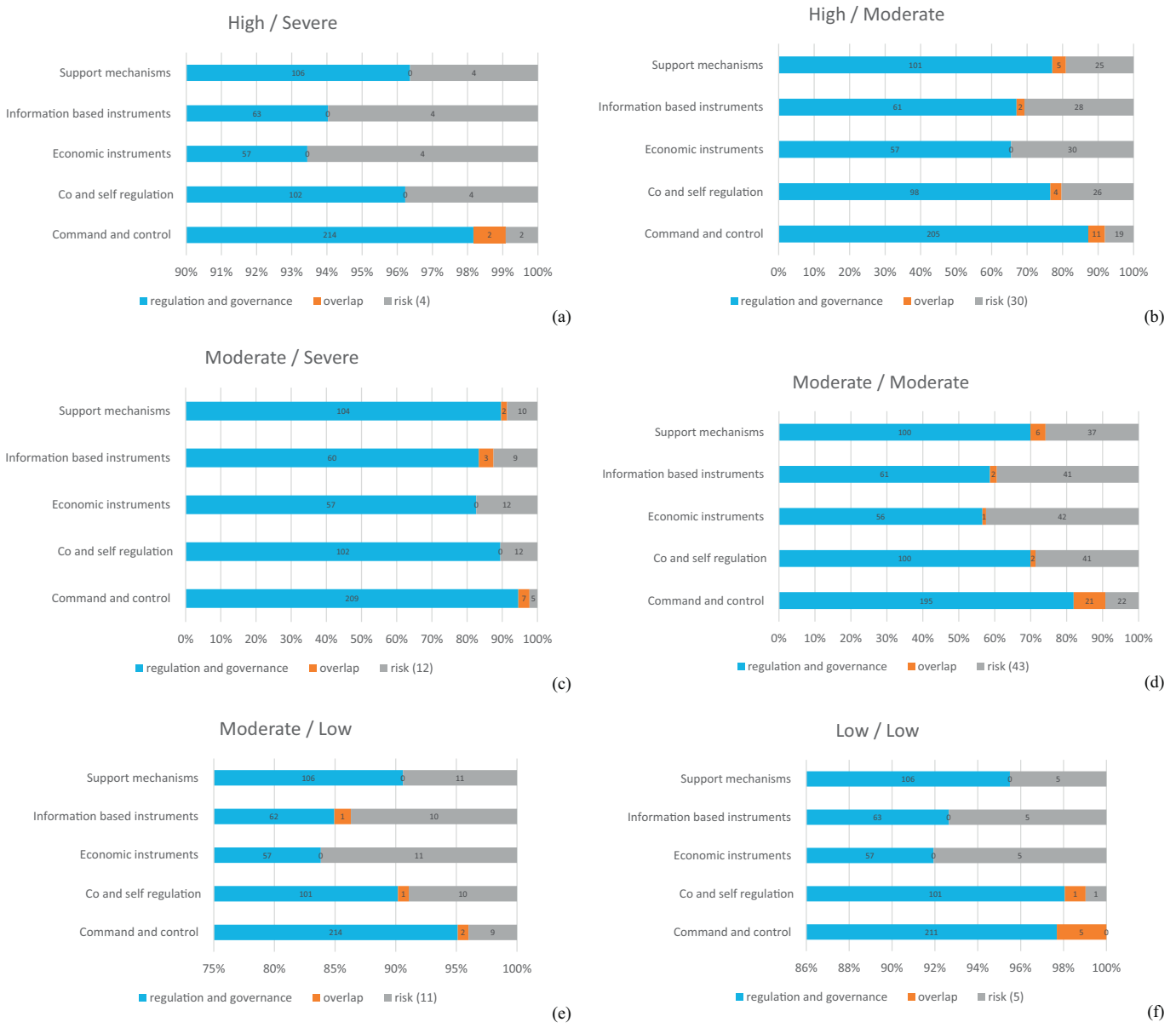


Fig. 10. a–f. Normalised stacked histograms illustrating overlap between codes for likelihood/impact risks of varying character (e.g. moderate likelihood/low impact; panel e, scale adjusted according to best fit).

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Appendix A. Sample interview questions

Question 1. Before we meet I will review the main areas of policy that I understand fall within your responsibility, and will begin the discussion by checking this understanding with you.

Question 2. The typology of instruments in Table 1 provides a broad categorisation of types of policy option that policy makers can choose from. Do you think this typology is comprehensive? Can you identify any significant gaps?

Question 3. I wish to compile a set of examples of policy instruments from UK environmental policy that have worked in practice, to use as data to compare with theories of what works when and why. Which policy instruments are you aware of that have worked well? Why has this been the case, and how has their effectiveness been demonstrated?

Question 4. Which policy instruments are you aware of that have worked less well? Why do you think this has been the case?

Question 5. Do you think policy in your area could be improved? Is there scope to make more use of approaches other than direct regulation?

Question 6. Thinking about the typology of instruments and the examples you have identified, which factors do you think determine whether or not a policy instrument will be effective for a given policy context?

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